

The Mediterranean agrobiodiversity wealth: an overview of minor fruit tree species

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Introduction

An extremely small number of crop groups (cereals and legumes) provide a large part of total food requirements worldwide. Wheat, rice and maize alone contribute more than 50% of the global plant-derived energy intake (FAO 1996).

About 20 crops including wheat, maize, rice, millet and sorghum, potato and cassava, peas, beans, sugarcane, coconuts and bananas (US National Academy of Science 1975) feed the world's populations. Not one of these is a fruit tree. In general terms fruits do not satisfy primary needs. This in part explains the relatively scarce incidence of fruit cultivation in global agricultural activities at least in terms of land use (fruits are cultivated on about 6% of arable lands), but perhaps not in terms of contribution to the elevation of the standard of living.

Fruits supply essential dietary factors such as vitamins and minerals and constitute, since ancient times, a customary integration of the alimentary habits of people worldwide. Furthermore, wild fruits and nuts were probably the main source of food prior to the domestication of cereal grains (Westwood 1993).

Asia and Europe alone today provide more than half the global fruit production, followed by South America, North and Central America, Africa, the former USSR and Oceania. Of all these areas the countries of the Near East and of the Mediterranean basin have, perhaps, the longest tradition in fruit culture for historical, environmental and evolutionary reasons. The Mediterranean basin is regarded as a primary centre of genetic origin and diversification of several temperate and subtropical fruit and nut trees (Vavilov 1951).

Olive (*Olea europaea*) and carob (*Ceratonia siliqua*) are good examples of this unique environment so that they are together considered as the guiding species of a specific Mediterranean phytogeographic association (Oleo-Ceratonion). Many other species, regardless of their real centres of origin – such as grapes, figs, almonds, pomegranates, dates and pistachios – have been cultivated there since the 3rd and 4th millennia BC (Zohary and Spiegel-Roy 1975) and represent, together with other crops (cereals and legumes), the key to the success of the traditional Mediterranean diet.

Some of the products of these fruit crops, particularly olive oil and to a minor extent red wine, have been the object of renewed interest over the last few years thanks to their contribution to preventing heart diseases. Furthermore, the traditional healthy Mediterranean Diet Pyramid has been recognized by the World Health Organization as a means for improving human good health and life expectancy.

Nevertheless many Mediterranean crops other than olive, such as carob pods, pomegranates, pistachios, loquats, persimmon and prickly pear have been neglected by the research for many years. Their possible contribution to the diversification and revitalization of local agriculture is now being re-emphasized in both the traditional and other areas of the world with a mediterranean climate such as California (31-41°N), Australia (28-35°S), South Africa (33-34°S) and South America (32-37°S).

The multipurpose role that can be played by some of them in industry, agroforestry and soil conservation, especially in marginal lands and semi-arid environments, is another reason of this renewed interest (Tous and Ferguson 1996).

From the point of view of genetic resources many socioeconomic and technical factors have contributed over time to the erosion of the varietal diversity. A good example of this

process of genetic erosion is offered by the pistachio. According to Maggs (1973) only about 100 female cultivars of *Pistacia vera* have been described until recently all over the world. In Italy only one cultivar ('Bianca') represents nowadays more than 90% of the total cultivated area, while a number of ancient minor varieties are thus liable to be easily lost forever (Barone and Caruso 1996).

The awareness of the risk of this relentless loss of genetic diversity has been perceived in different degrees by the scientific community and perhaps from a strabismic perspective.

From the Stockholm Conference on the Human Environment of 1973 to date, great efforts have been made to safeguard major fruit trees of major economic importance. It is now time to concentrate the attention and coordinate the efforts on the indigenous agrobiodiversity richness of neglected or underutilized fruit species of the Mediterranean region.

State of the art

Available information (FAO 1996) indicates that almost 50% of all accessions in genebanks worldwide are cereals, followed by food legumes, forages and vegetables. Fruits account for about 4% of global collections (Fig. 1).

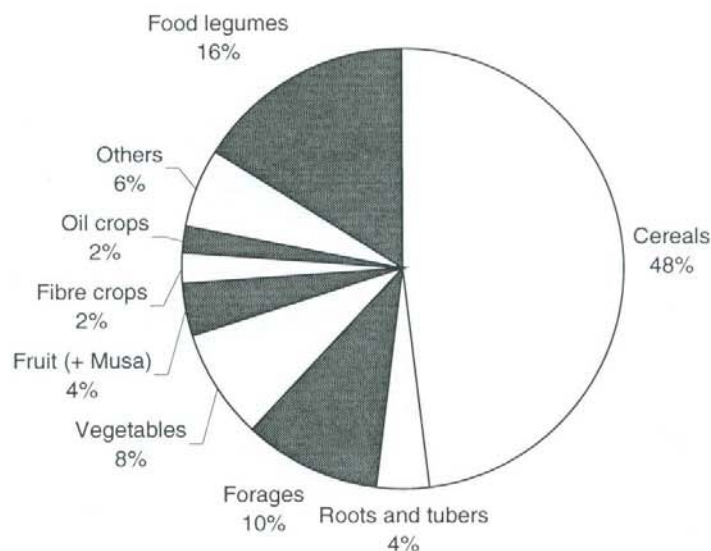


Fig 1. Contribution of major crop groups to total *ex situ* collections (Source: FAO 1996)

Among the major fruit tree species, the most represented species worldwide are apples (97 500 accessions), followed by *Prunus* spp. (64 500), grape (47 000), citrus (6000), hazelnut (2500), *Sorbus* spp. (2000) and pear (1000). Although incomplete and questionable, these data represent a very low figure especially when compared with major species of other crop groups (cereals, food legumes and vegetables). Furthermore, no official global estimates are available for several other major fruit tree species (olives, avocados, apricots, almonds). Nor is it possible to make even a rough estimate of the large number of minor fruit tree species.

Most European countries have local and central institutions responsible for domestic PGRFA (Plant Genetic Resources for Food & Agriculture) programmes (FAO 1996), but for the Near East, South and East Mediterranean subregions lack of coordination has been stressed, although some worthy initiatives are being coordinated by WANANET (IPGRI 1997).

The Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD) holds an important field genebank collection of fruit trees (FAO 1996).

The IPGRI's UMS (Underutilized Mediterranean Species) project focused its attention on *Pistacia* species and recently, as a result, released the descriptor lists for *Pistacia vera* and *Pistacia* spp. (IPGRI 1997, 1998).

FAO over the years has promoted a number of fruit-related networks: the Olive Genetic Variability Conservation Network; the Inter-regional Cooperative Network on Nuts; the Mediterranean Fruit-tree Network and the International Network on Cactus Pear (FAO 1996).

The European Commission (EU) gave some attention in the past to 'alternative species' within the 'Agrimed Programme' (Crescimanno 1988) and recently launched the 'European Programme on the conservation, characterization, collection and utilization of genetic resources in agriculture' (reg. 1467/94). In the framework of this programme an international initiative for the minor fruit tree species has been recently accepted by the EU.

The case of Italy

The state of Italian indigenous agrobiodiversity richness of fruit tree species was recently reviewed on the occasion of the National Congress on Conservation and Valorization of Fruit Germplasm that was held in Sardinia, Italy in 1992. In the proceedings of that meeting are reported the results of a 10-year national coordinated research project on 'Difesa delle risorse genetiche delle specie arboree da frutto' (Defense of fruit tree genetic resources), sponsored by the National Research Council (CNR) with the participation of a number of scientific institutions from almost all of the Italian regions.

About 100 papers on different species (almond, apple, apricot, cherry, citrus, olive, peach, pear, plum and vine) covered almost all the aspects related to the characterization and evaluation of the indigenous germplasm of the above-mentioned fruit crops.

As a further result of that project a complete inventory of Italian major fruit tree species genetic resources (Fig. 2) was therefore published (CNR 1994). In that inventory are reported in a synthetic form the results of the evaluation work carried out according to the main available descriptor lists. Nevertheless, since they were not included in the original framework of the project, very little attention was paid to minor fruit crops such as carob, fig, loquat, pomegranate, pistachio, quince, prickly pear, etc., although most of these neglected or minor fruit tree species have been cultivated for a very long time and are still present in Italy with a conspicuous germplasm (Pisani 1992).

In the meantime non-coordinated research activities have been carried out, but with few exceptions, they only referred to local, specific situations.

One of Italy's largest fruit tree germplasm collections is maintained by the Fruit Research Institute (ISF) in Rome. Among the almost 4000 different accessions of 29 different fruit species held by ISF (Fig. 2) are 27 pistachio varieties and 20 loquat, but carob, pomegranate or quince are not reported (Fideghelli *et al.* 1992). Temperate fruits (mainly apple, peach, cherry, apricot and pear) account for about 80% of the total, followed by nut crops (7.6%), small fruits (9.8%) and subtropical fruits, including loquat (2.6%).

In 1996 a specific international project, which included the participation of Italian universities and was supported by the EU (RESCEN Olive), was undertaken with the aim of preserving the genetic diversity of olive.

At the present time a recent initiative sponsored by EU is underway with a special emphasis on minor species (EC Project GENRES 29) and the involvement of 11 scientific institutions from four European countries (Spain, Greece, France, Italy) (Table 1). Up to now within this project, coordinated by the University of Florence (Italy), a first inventory of some collected accessions has been prepared and is available for eight species (fig, pomegranate, persimmon, loquat, prickly pear, quince, chestnut and pistachio) while the work of collecting is underway for carob, *Crataegus azarolus*, *Mespilus germanica*, *Arbutus unedo*, *Cornus mas*, *Zizyphus vulgaris*, *Sorbus domestica* and *Morus* spp.

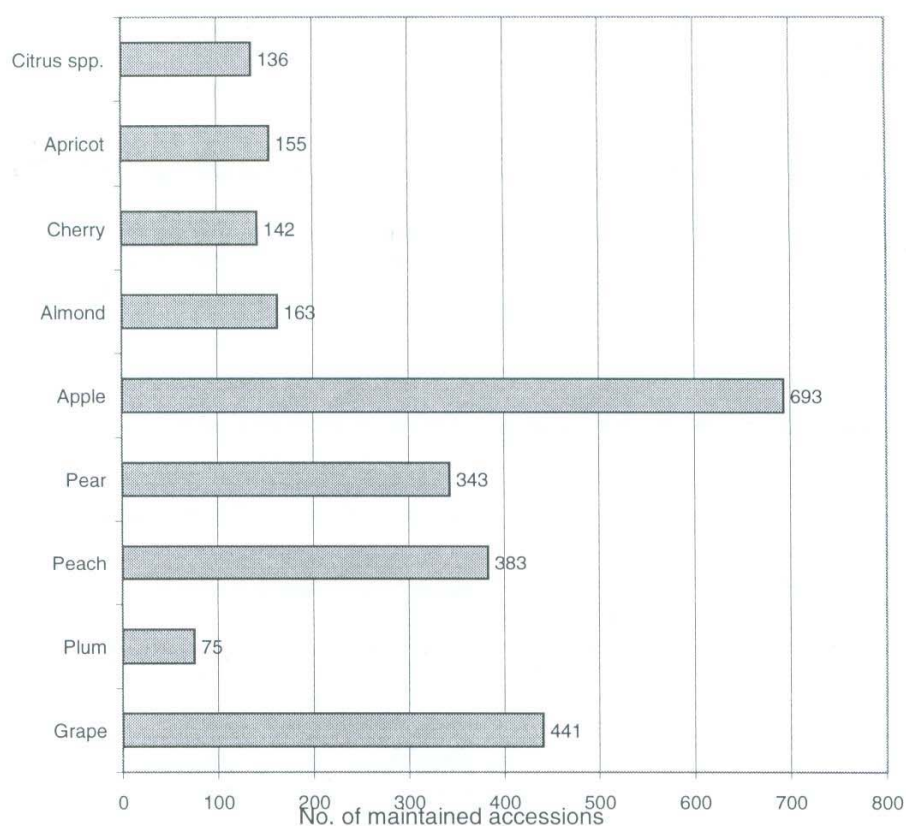


Fig. 2. Italian fruit tree germplasm accessions collected by different Italian Institutions as reported during the Italian National Congress on Conservation and Valorization of Fruit Germplasm (1992).

The main objectives of this coordinated research group are (1) to establish through a common strategy, a basis for the conservation and utilization of Mediterranean minor fruit tree species, (2) to create a European inventory, and (3) to develop a first database on germplasm collection comprehensive of both first and advanced characterization descriptors. The first results of this project are available at the web site of the University of Florence (<[http\www.unifi.it](http://www.unifi.it)>) and some of them are summarized in Fig. 3.

Table 1. Partners of the EC Project GENRES 29 (Conservation, evaluation, exploitation and collecting of minor fruit tree species)

Country	Institution	Coordinator
Italy	University of Florence	E. Bellini
Italy	University of Basilicata	C. Xiloyannis
Italy	University of Tuscia	C. Bignami
Italy	University of Naples	T. Caruso
Italy	University of Sassari	I. Chessa
Italy	ISF Rome	G. Grassi
Spain	IVIA Valencia	G. Llacer
Spain	Polytechnic University of Valencia	P. Melgarejo
Greece	SPOTI of Chania	S. Lionakis
Greece	NAGREF Naoussa	C. Tsiouridis
France	CBNP Hyeres	J.P. Roger

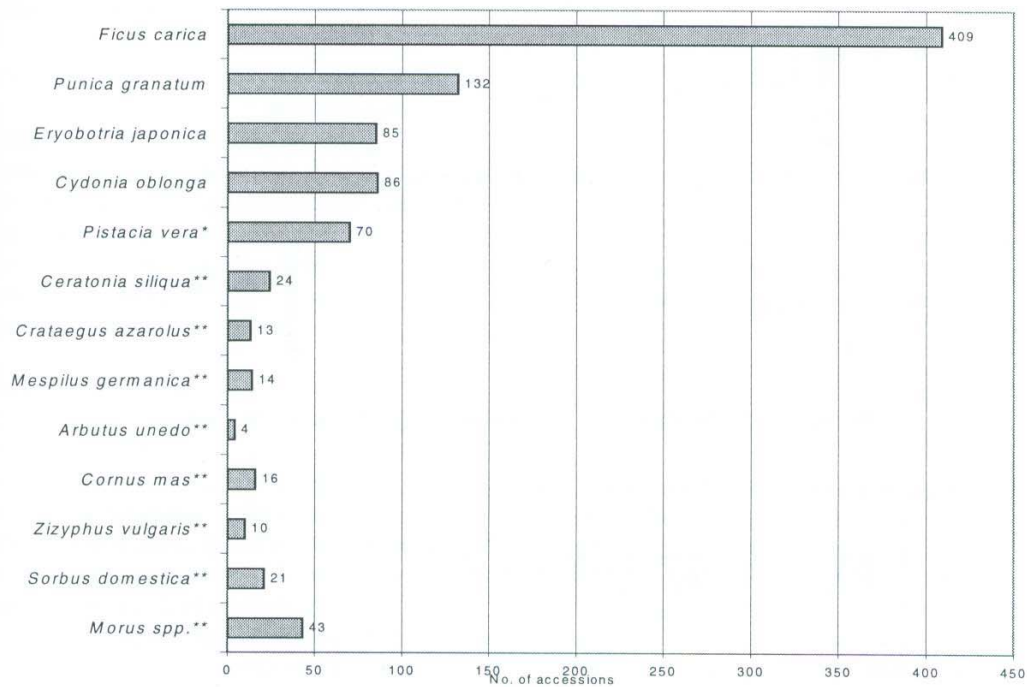


Fig. 3. Accessions collected by EU Programme GENRES 29 (started 1996): * = female accessions, ** = collecting in progress.

Definition of minor fruit tree species

The term Mediterranean Minor Fruit Tree Species (MMFTS) is here used as a collective definition referring to a group of underutilized or neglected fruits with economic potential in selected areas of the Mediterranean basin.

As defined by Ryugo (1988) minor fruit crops not only add colour and nutrition to our diet but also elevate our standard of living. Traditionally each of them plays at the local level an important role in the food habits of the Mediterranean people, while contributing to livelihood security, agricultural diversification and environment.

Nevertheless, the processes of fruit culture modernization and the change in consumer preference (advertising-oriented) strongly and continuously decrease their spread and economic importance while increasing their vulnerability and the risk of genetic erosion.

Hence, even if it is impossible to estimate how much diversity has been lost already, it is clear that lowering this loss is imperative. Furthermore, the loss of genetic diversity, especially in the case of neglected and underutilized species, is linked with the loss of potentially useful knowledge about this material.

The loss of genetic diversity can in fact be considered as a convergent result of both the processes of varietal replacement (very common for spread and intensively cultivated species) and the preservation of orchards of minor fruit crops (Fig. 4).

The examination during a long period of production trends, when available for selected countries and fruits, confirms both this decrease of economic importance and, consequently, the increasing risk of extinction of many varietal forms.

The Italian and Spanish carob production has halved between 1955-95 and 1970-55, respectively. The Italian production of quince has fallen from 14 000 t in the 1947-50 period to 1000 t nowadays. Italian pistachio production (in shell) has fallen from 2200 t of the 1930s to 1250 t in the 1980s.

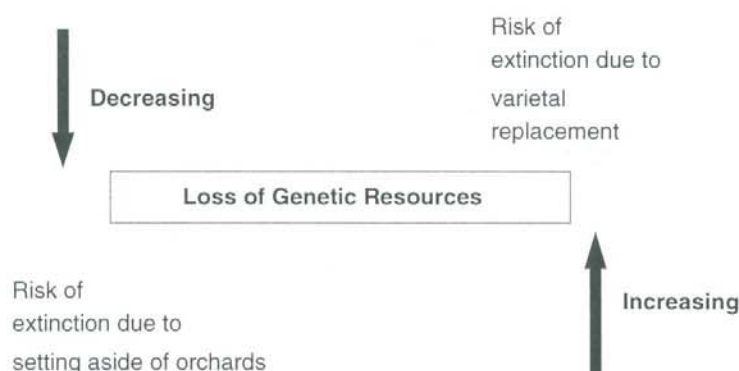


Fig. 4. How opposite productive trends can affect genetic resources.

Current conservation and development programmes tend to neglect these species (FAO 1996). MMFTS seldom receive the attention they deserve in national and international research programmes. In an attempt to assess how much research has been carried out on MMFTS, literature records were consulted and the results of this investigation were quite impressive, altogether the number of papers focused on (or simply mentioning) a selected number of MMFTS was much lower than that of some major fruits alone.

Rationale for using Mediterranean Minor Fruit Tree Species

Why should we pay attention to MMFTS? A tentative, non-exhaustive, list of possible reasons that make MMFTS worthy of interest is given below.

Historic value	Drought resistance
Landscape value	Salt tolerance (eventually)
Non-surplus products	Low environmental impact
Alternative products	Contribution to local diets
Potential new products	Alimentary value
Multiple-use products	Source of genetic traits
Multipurpose trees	Rootstocks
Low requirements (frugal species)	

The actual and potential utilization of a number of selected Mediterranean minor fruit tree species is summarized in Table 2. The current state of conservation of the Mediterranean minor fruit tree species listed in Table 2 is briefly reviewed here.

Table 2. Actual and (potential) utilization of some Mediterranean minor fruit tree species

Latin name	Common name	Utilization				
		Fresh fruit	Transformed products	Forage/browse	Medicinal	Orna-mental
<i>Arbutus unedo</i>	Strawberry-tree	X	X	X	(X)	X
<i>Ceratonia siliqua</i>	Carob	(X)	X	X	X	X
<i>Cydonia oblonga</i>	Quince	(X)	X		X	X
<i>Cornus mas</i>	Cornelian cherry	(X)	X		(X)	X
<i>Crataegus, Azarole</i>	Azarole	X	X			X
<i>Mespilus germanica</i>	Medlar	X	X		X	X
<i>Morus alba</i>	Mulberry	X		X		X
<i>Morus nigra</i>	Mulberry	X	X		X	X
<i>Punica granatum</i>	Pomegranate	X	X		X	X
<i>Sorbus domestica</i>	Sorb	X	X		X	(X)
<i>Zizyphus vulgaris</i>	Jujube	X	(X)		(X)	X

Pomegranate

Scientific name: *Punica granatum* L. (**Family:** Punicaceae)

Origin and history

Pomegranates are native to southeastern Europe and Asia and were grown for thousands of years in ancient Egypt, Iraq, India and Iran. Cultivated extensively in Spain, Tunisia, Turkey, Egypt and Morocco, but sparsely grown in most Mediterranean countries. Pomegranates moved with missionaries into Mexico and California in the 16th century. Often used as an ornamental tree. Global commercial production is 800 000 t, with a stable trend (Tous and Ferguson 1996).

Genetic resources

The main germplasm collection is located in Spain (80 accessions). Italy and Greece also have small field genebank collections. Characterization and evaluation of some varieties have been carried out, but most of the accessions have yet to be evaluated. Many cultivars are present around the world, and it is possible to divide them into two groups: sweet and bitter-sweet (sourish). 'Wonderful' is a cultivar grown commercially in California and Israel, having been exported as cuttings from Florida, 'Mollar' and 'Tendral' in Spain, 'Hicaz' in Turkey, 'Zehri' and 'Gabsi' in Tunisia, 'Purple Seed' and 'Spanish Ruby' are popular garden cultivars in the USA, 'Dente di cavallo' and 'Melograno dolce' in Italy.

Quince

Scientific name: *Cydonia oblonga* L. (**Family:** Rosaceae)

Origin and history

Native to the warmer regions of southeastern Europe and Asia Minor. Largely appreciated by the Romans and the Greeks. The cultivation for fruit production was in the past mainly located in Greece and in Italy. Now it is decreasing and many varieties are disappearing. Nonstringent varieties are grown in Central Asia. Quince is a source of dwarfing rootstocks for pear and loquat.

Genetic resources

Collection of genetic resources is incomplete. Evaluation is in some cases underway. Collections are located mainly in Greece (57 accessions) and Italy (29). High variability is documented for fruit shape (apple-like, pear-like). In Italy, in the late 1950s at least 20 varieties were known and described (Scaramuzzi 1958).

Carob

Scientific name: *Ceratonia siliqua* L. (**Family:** Leguminosae)

Origin and history

Native to southwestern Asia and Mediterranean basin. Carob is used for many purposes for food, fodder, gums, sugar and alcohol, shade and erosion control (Battle and Tous 1997). It is recovering economic interest particularly for the extraction of emulsion stabilizer and thickening substances from seeds (Battle and Tous 1988; Crescimanno 1988). The cultivation (total area 146 701 ha) is mainly in Spain (60%), Italy (11.7%), Greece (8.6%), Morocco (7.1%), Portugal (6.2%), Turkey (2.2%) and Cyprus (1.7%) with lesser quantities in Algeria, Tunisia and Israel. Global commercial production is 245 000 t, with a stable trend (source: FAO 1996).

Genetic resources

From the agronomic point of view, varieties have been traditionally divided into two groups: wild and domesticated. This distinction refers to the different ratio between pulp and seed. Domesticated varieties have traditionally been selected for higher pulp and sugar content whereas wild varieties have larger proportion of seeds, from which is currently extracted the most valuable product (carob bean gum). The most important commercial cultivars are 'Negra', 'Rojal', 'Matalafera' in Spain, 'Latinissima', 'Racemosa', 'Gibiliana' and 'Amele' in Italy, 'Mulata' and 'Galhosa' in Portugal, 'Sfax' in Tunisia, 'Hemere' in Greece. Of high genetic interest is the occurrence of hermaphrodite cultivars.

Collections are maintained in Spain (Reus: 68 accessions; Alicante: 135 accessions), Portugal (13), Tunisia (10) and Greece (Batlle and Tous 1997). Molecular markers showed low polymorphism among the Spanish cultivars. Nevertheless wide variability can still be found (number, size, weight, content of seed and pulp, vigour, yield, pest and disease resistance).

Azarole

Scientific name: *Crataegus azarolus* L. (**Family:** Rosaceae)

Origin and history

Native to Asia Minor, but naturalized since ancient times in the Mediterranean basin, mainly in warm semi-arid regions. Cultivated sparsely both for fruit and ornamental purposes.

Genetic resources

Very few cultivars, differing in fruit shape, are known: in Italy 'Bianca d'Italia', 'Rossa d'Italia' and 'Gialla del Canada'. A collection of 13 accessions has been established recently in central Italy. Selected clonal *Crataegus* are being developed as dwarfing stocks for pear in the USA (Westwood 1993).

Jujube (Chinese jujube – Chinese date)

Scientific name: *Zizyphus vulgaris* L. (syn. *Z. sativa*, *jujubes*) (Related species: *Z. mauritiana* = Indian jujube) (**Family:** Rhamnaceae)

Origin and history

Introduced from China and central Asia at the beginning of the Christian era and naturalized in the Mediterranean countries for its fruits (Lyrene and Crocker 1994). Grown to a lesser extent in Russia and the southwestern USA. The fruit, a drupe, is mild and sweet and reportedly contains a high concentration of vitamin C. It matures in September-October and is picked for canning or fresh market when the skin turns red-brown. The fruit is generally eaten after it becomes wrinkled. The species is often grown as an ornamental.

Genetic resources

Over 400 cultivars have been selected in China where wild types can still be found. No commercial cultivars are available in most Mediterranean countries. 'Li' and 'Lang' are two varieties available from nurseries, especially in the USA. Generally two types are recognized: long-fruited shape and oblong-fruited shape. Very limited knowledge and, presumably, narrow genetic base in the Mediterranean countries. A small collection (8 accessions) is maintained in Greece.

Potential and constraints

Considerable potential for garden plantings: disease resistance, good adaptation, well

adapted to poor soils, precocity of flowering, ease of propagation. Lack of information on cultivar performance and scarce availability of selected plant material. The fruit is not easily recognized by the potential consumer.

Sorb

Scientific name: *Sorbus domestica* L. (Family: Rosaceae)

Origin and history

Native to southern Europe, Asia Minor and northern Africa. Mainly spread as isolated trees. The genus has potential for use as rootstock as it is partly compatible with apple and pear and is compatible with quince and azarol (Westwood 1993).

Genetic resources

About 20 accessions have been collected in Italy. Two main types are generally recognized: apple-like fruits and pear-like fruits.

Potential and constraints

Frugal and relatively tolerant to calcareous, heavy soils. Fruit can be eaten only after post-maturation treatments. Low market potential, despite its fame as a biological product.

Medlar

Scientific name: *Mespilus germanica* L. (Family: Rosaceae)

Origin and history

Native to Asia Minor. Introduced and naturalized in the Mediterranean countries for its fruits during the Roman era.

Genetic resources

Largely unexplored. Very few varieties are commercially available: in Italy these are 'Nespolo comune', 'Grosso di Germania', 'Nespolo d'Olanda' and 'Gigante di Castel Rainero'. Still propagated by seed, should have a more rich and complex genetic base. About 8 accessions are maintained in field genebanks in Italy and 5 in Greece.

Potential and constraints

It is a frugal species. Fruits can be eaten only after post-maturation treatments. Good market potential in limited areas. Known as a biological product. Wood is highly appreciated for its quality and properties.

Strawberry-tree

Scientific name: *Arbutus unedo* L. (Family: Ericaceae)

Origin and history

Natural component of Mediterranean maquis, generally on siliceous soils. Diffused also in northern Europe by the Romans for its fruit. Fruit is not very tasty (the Latin name *unedo* means "eat one of it", suggesting that one is enough). Wood is used for flute production in Greece. Appreciable ornamental value.

Genetic resources

Very limited knowledge. Only a small collection is maintained in Greece (4 accessions).

Mulberries

Scientific name: *Morus* spp. L. (**Family:** Moraceae)

Origin and history

Introduced in the Mediterranean countries for its sweet, pleasantly flavoured fruits (black mulberry) and for the silk industry (white mulberry). Largely cultivated in the past, today exists only as isolated trees. The fruits are too tender to be easily handled for market.

Genetic resources

Very limited knowledge. The largest collections are those of *M. alba*, used in the silk industry until recently. Twenty accessions of this species have been collected in France. *M. nigra* is currently less represented in field collections.

Cornelian cherry

Scientific name: *Cornus mas* L. (**Family:** Cornaceae)

Origin and history

Native to south-central Europe and western Asia. Its fruits are rich in tannins, sugars and mucilage.

Genetic resources

Very poor knowledge. No commercial cultivars are available.

General remarks and recommendations

With few exceptions the above-listed species have suffered in a generalized manner from lack of attention and research.

Major constraints***a) Aspecific***

Lack of economic interest
Change in the consumer's habit
Lack of sufficient technical, agronomic, industrial know-how
Competition with major fruit crops
Niche products

b) Plant-specific

Long juvenility period
Long reproductive period
Consumption generally after post-maturation processes
Lack of improved cultivars

Major research needs can be identified in the areas of:

Propagation techniques
Adaptation tests
Cultural systems
Suitability for intensive farming systems
Food technology research
Potential use, new products, byproducts
Economic aspects of cultivation, processing and marketing

Conclusions

The genetic resources of the MMFTS are today being largely unexplored, and so are their interesting potentials. Among those most urgent actions needed to promote these species are the following.

Priorities

Identify major areas of high genetic diversity
 Survey the existing diversity, also among wild relatives
 Assess vulnerability
 Collect and collate all available data and ethnobotanical information at local level
 Catalogue and coordinate the existing PGR initiatives

Intermediate objectives

Development of descriptor lists
 Promotion and establishment of *ex situ* conservation initiatives
 Evaluation and characterization

Long-term objectives

Promotion of *in situ* conservation
 Promotion of *in situ* conservation of wild relatives
 Promotion of use
 Promotion of breeding and genetic research
 Development of new cultivars and rootstocks.

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